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term in the variation of latitude will probably throw on it, the problem must be again examined, and exhaustively. It is hoped that Messrs. Thackeray and Turner will again cover the already well-travelled ground back to 1851.

I beg to add a remark on an important point. It might be maintained that the annual term in the latitude-variation is illusory, and merely the indication of a generally prevailing instrumental disturbance, due to temperature, and affecting all instruments and methods alike. This would be possible, but, in view of the actual facts, it is not at all probable. This explanation would require the maximum and minimum phases to occur in midwinter and midsummer, and at the same dates in all longitudes. This is not the case. The American observations, with the apparent exception of one series, place these phases three or four months earlier than the European; indicating a rotation from west to east for this annual term, the same as has already been proved, from the observations, for the 427-day term, independently of the theoretical considerations which require it to be so.

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Latitude Variation and Greenwich Observations, 1851–91.

By W. Grasett Thackeray.

A preliminary paper on this subject was communicated to the Society in November last by Mr. Turner and myself. In it there was found to be indisputable evidence of the Chandler wave period, and grounds were shown for suspecting a five-yearly disturbance. This paper will be found to deal with—

1. The verification of the Chandler curve, as given in No. 277 of the *Astronomical Journal* ;
2. The vindication of the correctness of the Greenwich Transit Circle Observations, more especially 1851–65.

1. The verification of the Chandler curve.

Since the publication of the first paper, the observations made at Honolulu and the allied observatories have added their testimony to the existence of a latitude variation, and Mr. Chandler in No. 277 of the *Astronomical Journal* has interpreted afresh the results of the laborious investigations he has undertaken on this subject. For a single term with a varying period he has substituted the resultant curve of two periodic fluctuations. The first of these two terms he has shown to have a period of 427 days and a semi-amplitude of about $0''\cdot12$; the second an annual period depending on the Sun's longitude with a semi-amplitude ranging between $0''\cdot04$ and $0''\cdot20$ during the last half century. In the same paper are also given curves showing the theoretical value of the latitude from 1840–1894 and the twenty-days' groups of observations from 1840–1891 upon which the theory was founded.

This theoretical curve and the observations on which it depends have been compared with the Greenwich observations as

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represented by the monthly means of the four close circumpolars *Polaris*, *Cephei* 51, δ *Ursæ Minoris*, and λ *Ursæ Minoris* for the years 1880–1891. The observations are taken from the N.P.D. ledgers of the volumes of Greenwich Observations, are reduced with Bessel's Refractions, and to the co-latitude value of 21″·90, and are not corrected for flexure or R−D: that is, where they have been corrected for flexure they have been recorrected to make the flexure = ·00. For discussions on the subject of the value of the correction for flexure as derived from the observations on the collimators, reference should be made to papers on Greenwich North Polar distances by Mr. Christie in *Memoirs R.A.S.*, vol. xlv., and by Professor Newcomb, in vol. ii. of the Astronomical Papers of the American N. A. office. The mean monthly values have been reduced to the epoch 1885. The precessions corresponding to the R.A. of each star at the middle of each year have been taken from Folie's Tables, and added together to reduce the results of the several years to the epoch 1885. The proper motions were taken from the Ten-Year Catalogue.

The differences between the monthly means thus reduced to 1885 and the adopted place for 1885 were then formed by taking monthly mean minus adopted place, both for above and below pole observations, and were combined with weights according to the number of observations.

The adopted places for 1885 were as follows :—

	°	′	″
Polaris	1	18	16·15
Cephei 51	2	46	33·98
δ Ursæ Minoris	3	23	22·27
λ Ursæ Minoris	1	2	40·18

As these stars are all close to the pole, any correction as now applied for R—D or flexure will be practically the same for all of them, and as the R−D variable term is found to be practically constant for these years, will only affect the zero line. Any error in the adopted places will, however, affect the form of the curve unless the above and below pole observations in any month are equal. Separate curves were also formed including and excluding the daylight observations of *Polaris* and *Polaris s. p.*, from which it was evident that there was no systematic error due to the daylight observations.

These differences, the same as were published in the first paper in November, were finally smoothed by taking the means of every three. It may be remarked that from the end of 1885 to the beginning of 1889 Mr. Chandler appears to have had no observations under investigation. The general accordance between all three curves is wonderfully good, and therefore the divergence of the Greenwich Observations at the beginning of 1881 is to be scanned with the more critical eye.

Mr. Chandler's curves representing theory and the twenty-days' groups of observations have been copied direct from his paper. It was occasionally found a little difficult to follow the latter.

2. The vindication of the correctness of the Greenwich

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Transit Circle observations in general, and those for 1851–1865 in particular.

On page 86, No. 251 of the *Astronomical Journal*, Mr. Chandler makes remarks to the following effect:—That the Greenwich observations with the Transit Circle for 1851–65, complicated with instrumental error and large accidental errors of observation, seem to frustrate efforts to get any pertinent results. We at Greenwich have noticed for some time a disposition among foreign astronomers to disparage the Greenwich observations. Scattered up and down foreign astronomical literature remarks such as the following may be found far too frequently:—The results are not accordant; the instrumental errors are complicated; the accidental errors are large and abundant; the observations have been rejected. To such I would remark that uniformity is not synonymous with truth, and that systematic errors are oftentimes the penalty of close agreement; it is to discordant and not to accordant observations that astronomy owes its most brilliant discoveries. In the volume of *Greenwich Observations* every step in the reductions is clearly set down, and the details of all instrumental errors carefully published. A discordant observation at Greenwich has never been rejected simply because it was discordant; but all results have been published, so that anybody using the observations can exercise his own discretion in retaining or rejecting such observations. The fact that Mr. Chandler has, after careful consideration, rejected sixteen years of observations with the Greenwich Transit Circle in such an important investigation as that on which he is engaged, and prefers to use the results of the Reflex Zenith Tube, is so striking that it becomes imperative to closely inquire into the subject. For this purpose I have taken the observations of the four close circumpolars as the representatives of the Greenwich Transit Circle observations.

The observations now under discussion comprise the rest of the series of the Greenwich Transit Circle observations—that is, from 1851–1879. The same stars have been used, the same method of reduction adopted, Bessel's Refractions, colatitude 21″·90, and no correction for flexure or R – D. The observations from 1851–1867 have all been reduced to the epoch 1860, and the observations from 1868–1879 to the epoch 1875. The precessions have been found in the same way, and the results found in an exactly similar manner, and compared with Mr. Chandler's curves representing his latest theory (that is law of eq. 15, *A. J.*, No. 277), and the twenty-day groups of observations on which his theory is based. The following are the adopted places of the stars at the two epochs:—

Epochs	1860			1875		
	°	′	″	°	′	″
Polaris	1	26	12·90	1	21	26·30
Cephei 51	2	45	6·00	2	45	55·30
δ Ursæ Minoris	3	23	53·20	3	23	32·50
λ Ursæ Minoris	1	6	35·23	1	4	8·40

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For the years 1868–1874 an additional correction, due to wear of the micrometer screws, is required, for particulars of which reference can be made to the Nine-Year Catalogue, 1872, in the introduction to which catalogue will be found a full and complete explanation. The results of the Greenwich observations thus corrected and reduced to one homogeneous system, when compared with the observations which Mr. Chandler has gathered together from all parts of the world, show a wonderful similarity of contour and general agreement in detail, the more remarkable when it is considered that many of the observations so collected by Mr. Chandler were made for special purposes with special instruments, with a special view to a discussion of this character. The agreement between all the curves is so good that the deviations become all the more accentuated, and, as Mr. Chandler remarks, in speculations on this subject it seems desirable to hold to a prudent reserve for further investigation. Incidentally to this investigation several other important questions have arisen, which are still under discussion.

Nova Aurigæ. By Isaac Roberts, D.Sc., F.R.S.

A photograph of the region of *Nova Aurigæ* was taken on October 3, 1892, with the 20-inch reflector, and exposure of 110 minutes, upon which the *Nova* appears as a star, as well defined as any of the other stars, which are very numerous, on the plate. There is no trace of nebulosity surrounding the *Nova*, or in its vicinity, and there is no feature about it suggestive that it is different from other stars. The diameter of its photo-image measures 21 seconds of arc, and about 85 seconds distant from it, on the *n.f.* side, is a star the photo-image of which measures 23 secs. of arc; the *Nova* is therefore 2 seconds in diameter less than the star.

On December 25, 1892, another photograph was taken of the same region, with an exposure of 20 minutes, upon which the *Nova* has a photo-image of 13 seconds of arc in diameter, and the star referred to has a diameter of 16 seconds. If we proportion the measured diameters obtained on the days stated, we shall have the following:—

$$23'' : 16'' :: 21'' : 14''\cdot63, \text{ the diameter of } \textit{Nova}.$$

But the diameter of the *Nova* measures only 13 seconds, which shows a decrease of 1″·63 in diameter between October 3 and December 25.

There is no indication of nebulosity round the *Nova*, or in its vicinity, on the December plate, and it appears as sharply defined as the other stars.

So far, therefore, as the evidence obtained by the eleven